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SOME PINEAPPLE PROBLEMS.

8th ARTICLE. - FERTILIZERS.

By Henry C. Henricksen.

AMMONIA. - Nitrogen may be present in the soil or in fertilizers in the form of nitrates, ammoniates or as ammonia ir organic form. The usual practice in pineapple growing is to apply a small amount of cottonseed meal or tankage in the center of the plant immediately after setting. This is for the purpose of preventing the young plant from being choked with sand and also to furnish ammonia. Altogether the practice is to be recommended but the fact remains that some cheaper material that does not contain nitrogen or ammonia may be used, as the plants can make no use of nutrients until roots are formed, some four weeks, or more, after setting. Some think that the ammonia of cottonseed meal will not be available until that time, but the fact is that a great deal may be available in a few days after the meal is applied. Very often so much becomes available that it burns the plant. When such burning takes place it is usually thought that the cottonseed meal must have been mixed with inorganic salts for the purpose of raising the nitrogen and potash content. That, however, is evidently a mistake for cottonseed meal when so mixed does not necessarily burn. Neither does cottonseed meal itself always cause burning although it may do so under certain conditions. For instance, during a period of light rains or heavy dews enough moisture will be present to cause the meal to ferment. One of the products of fermentation is ammonia and if that remains in the heart of the plant it burns the leaves. On the other hand, if a heavy rain comes at that time it washes the ammonia onto the soil and no burning takes place.

Cottonseed meal and other organic materials are also used for general fertilizing, but much less so nowadays than it was ten to fifteen years ago. Ammonia is now usually applied in the form of ammonium sulfate. This is, according to practical experience, giving much better results than sodium nitrate and for that reason the belief has gained ground that the pineapple plant prefers its nitrogen in the form of ammonia. That belief does not seem unreasonable considering that the plant belongs to a family of air plants, but as a matter of fact it is wrong. The pineapple plant prefers its nitrogen in the form of nitrates; seldom, if ever, does it take up ammonia from a water solution. Ammonia is changed into nitrogen whenever the conditions are favorable, the factors governing the process are moisture, air, temperature, the presence of some organic matter (carbc-hydrates), the proper bacteria and a certain limit of acidity within which the bacteria will thrive. Generally these factors are favorable in a soil that is suitable for pineapple growth. Therefore, it is to be expected that ammonia, in any form, will be readily changed into nitrogen in such soils. Actual tests show that some change does take place very rapidly for considerable nitrate is found in the soil a few days after an application of ammonia. On the other hand much ammonia is usually present several weeks after the application has been made, showing that all of it does not necessarily change quickly. This is of practical importance, for ammonia is held by the soil to a much greater extent than is nitrate. That is, under certain conditions, the loss of nitrate nitrogen due to leaching may be great whereas under the same conditions the loss of ammonia will be but slight.

NITRATES. - Nitrogen may be present in the soil or in fertilizers in the form of nitrates, that is, in the form of nitric acid in combination with some base, usually sodium, potassium or calcium. To some plants it seems to make little difference what the combination is but, as stated before, the pineapple plant is very sensitive to bases. In water culture and pot experiments potassium nitrate has given excellent results. In fact, tap water with the addition of potassium nitrate has usually produced as good growth as rain water with the addition of phosphate, lime, iron, etc., showing that the plants needs are satisfied with minimum amounts of the latter elements, provided both nitrogen and potash are present in abundance. Field experiments as well as general experience have shown that sodium nitrate and calcium nitrate are not suitable combinations to use in a pineapple fertilizer. As for potassium nitrate, there is not yet enough data available, but the indications are that it is suitable.

AMMONIATES VS NITRATES. - When organic materials are applied to the soil, the first fermentation produces ammonia, which is a base and which will for that reason combine with any acid present in the soil. If enough acid is present, the soil may remain acid after the ammonia has been neutralized, but if the acidity is slight the ammonia will combine with carbonic acid and the soil reaction may be changed very much towards alkalinity. That is the reason why organic materials do not always produce the desired results. Those, who for some reason prefer organic materials, should test their soils as explained in the 4th article of this series. If the pH is not towards 5 or below that, an application of sulphur should be made simultaneously with the fertilizer.

After an application of organic matter, the second fermentation process changes the ammonia, formed in the first, into nitrous acid which is almost immediately changed into nitric acid. This acid will attach itself to any base in the soil that is free or that is combined with a weaker acid. It will, therefore, partly offset the effect of the alkalinity produced by the ammonia and as nitrification is fairly rapid that alkalinity would seem to be of minor importance, yet experience shows it to be not so. Ammonium sulfate is very much superior to organic nitrogen seemingly because of the sulfuric acid it contains. That points towards the probability that sulfur or some other material may have to be used in combination with potassium nitrate if that is to give maximum results on soils that are not acid. This will be discussed further when more data becomes available.

POTASSIUM. - This element, when used as a fertilizer, is always in combination with some acid, usually sulfuric or muriatic. As nitrogen and phosphorus are acid-forming elements, it would seem reasonable that potassium nitrate and potassium phosphate should be used for pineapple fertilizers, but the former is used but very little and the latter not at all. Both would seem to be acceptable if they were cheap enough, but at present the sulfate and the muriate are the commercial combinations used. The sulfate is entirely acceptable to the pineapple plant and for that reason, neither the muriate nor the double manure salt has been considered in this work.

It is not difficult to understand why a mixture of ammonium sulfate and potassium sulfate is a desirable pineapple fertilizer. The potassium and the nitrogen are both taken up by the plant whereas the sulfuric acid, with which both were in combination, serves to keep the colloidal matter in the soil in a state of coagulation. The amount of sulfuric acid supplied in the fertilizer is not inconsiderable as shown by the following example. Fertilizer applied per acre for first crop:

Ammonium sulfate	800 lbs.	= 594 lbs.	sulfuric acid
Potassium sulfate	350 lbs.	= 197 lbs.	sulfuric acid
Total sulfuric acid		791 lbs.	

Potassium sulfate is water soluble; therefore, when it is applied to a soil containing sufficient water, it goes into solution very quickly. If the soil is leached with water immediately after the salt is applied, a large portion of it can be recovered, but if the leaching is deferred for some months recovery is much more difficult. This is of practical importance, for it shows that the soil is capable of retaining potash even though the rains are extra heavy, although a heavy rain within a few days after fertilizing may leach considerable of it out.

PHOSPHORUS. - In fertilizers or in the soil phosphorus is always in combination with enough oxygen to form phosphoric acid. That again is in combination with some base, usually lime. The combination may be tri-calcium phosphate, such as in bone meal, which is not soluble in water and very little soluble in weak acids and must, therefore, be very finely pulverized in order to be of use to plants. The coarse-ground bone meal sometimes sold in Porto Rico is very slowly available especially on sandy soil. Another combination is di-calcium phosphate which is usually referred to as "reverted". It is considered more readily available to plants than the former but less so than the following. A third form is mono-calcium phosphate which is readily available to plants although it is but slightly water soluble. This form is the one mostly used for fertilizers under the name of acid phosphate. It may be the so-called single grade containing about 15% phosphoric acid or it may be the double grade containing up to 40%.

In this investigation the experience with calcium phosphate indicates that either the combination is unsuitable, or else that the pineapple plant does not need much phosphate. Field experiments are now under way, the results of which will show whether or not potassium phosphate and ammonium phosphate are more suitable. Until that work is finished no recommendations in regard to phosphorus can be made.